NEW YORK ENTOMOLOGICAL SOCIETY
91(4), 1983, pp. 503–507

RECOGNITION OF HOST NEST ODOUR BY THE BUMBLEBEE SOCIAL PARASITE *PSITHYRUS ASHTONI* (HYMENOPTERA: APIDAE)

Richard M. Fisher

Biology Department, Erindale College,
Mississauga, Ontario, Canada L5L 1C6

Abstract.—The ability of the social parasite *Psithyrus ashtoni* to identify and discriminate between nest odours of different bumblebee species was investigated. Female *P. ashtoni* were presented with various combinations of host nest, non-host nest and nest material alone. Parasites showed preference for the odour of the host nests rather than nest material or nests of non-host bumblebees. The importance of host nest odour identification to searching parasites is discussed.

Bees belonging to the genus *Psithyrus* are obligate brood parasites of bumblebees (Hymenoptera: Apidae). Female *Psithyrus* emerge from hibernation some time after host bumblebee queens and search for established nests, most of which are underground in abandoned rodent burrows (Alford, 1975). How are host nests located? Early investigators of *Psithyrus* biology (e.g., Sladen, 1912; Plath, 1934) believed that the scent of host nests were detected by searching parasites. More recently, Cederberg (1979) suggested that *Psithyrus rupestris* Fab. follows odour trails produced by host *Bombus lapidarious* Linn. workers. These trails are made by workers as they wander in and out of subterranean burrows leading to the nest (Cederberg, 1977). Worker extract daubed on filter paper is followed by *P. rupestris* females.

P. ashtoni Cr. is parasitic in nests of *Bombus affinis* Cr. and *B. terricola* Kby. (Plath, 1922). It searches for nests within one–two weeks of host queen emergence (Fisher, unpubl.), at a time prior to emergence of the first worker brood, and therefore cannot use odour trails of workers to recognize nests. Since bumblebee queens incubating incipient brood clumps leave the nest at irregular intervals to forage (Alford, 1975), their nests may be difficult to locate if odour trails of queens are being used. In addition, *P. ashtoni* is found only in nests of *B. terricola* and *B. affinis,* unlike many other *Psithyrus* species which are not host specific. Can *P. ashtoni* identify host nests by odour without relying on worker trails, and can it discriminate host from non-host bumblebee species? Investigation of the ability of *P. ashtoni* fe-

---

The publication costs of this article were defrayed in part by page charge payment. This article must therefore be hereby marked *"Advertisement"* in accordance with 18 U.S.C. §1734 solely to indicate this fact.

males to identify and discriminate between odours of different bumblebee species is the subject of this paper.

METHODS AND MATERIALS

Bumblebees were reared in the laboratory using the techniques of Plowright and Jay (1966) and Pomeroy and Plowright (1980) during May 1982. Female *P. ashtoni* were caught as they searched for nests and maintained in small wire cages with access to pollen and sugar-water solution.

Each bumblebee nest starting unit consists of a 17.5 × 12.5 × 10 cm outer box with glass lid where queens collect sugar water and void faeces. The outer box is connected by a 1cm diameter hole to an inner box (ID 77 × 77 × 50 mm) with closed glass lid. The inner box contains upholsterer's cotton and a moist pollen lump in which captive queens lay eggs. Each inner box is detachable and easily moved about once the entrance hole is plugged.

I chose representative nests of *B. terricola, B. affinis,* and a non-host species (*B. bimaculatus* Cr.) for this experiment; all were at the same stage of development (first brood workers in cocoon stage, second brood eggs laid). This is the approximate stage of nest development when *P. ashtoni* is nest searching. I plugged and removed boxes containing nests and queens and placed them in a darkroom cubicle in another room. The glass lid from each box was removed and replaced with wire mesh screen stapled in place.

A plexiglass cage which exactly fit the outer dimensions of two nest boxes placed side by side was constructed. This cage had a removable plexiglass lid and detachable wire mesh floor. The cage was supported off the nest boxes by 4 mm strips of plexiglass so that no part of the cage floor came in contact with the wire mesh tops of the nest boxes.

Boxes containing nests of the three bumblebee species or upholsterer's cotton alone were placed side by side in various combinations. A female *Psithyrus* was brought into the darkroom and placed in the plexiglass cage. It was allowed one minute to wander around the cage. A single 40 W red light illuminated the apparatus from a central location. The midline of the cage floor had been marked; when the female *Psithyrus* was in the middle of the cage it was lowered onto the nest boxes. The proportion of time each female *Psithyrus* spent on either side of the midline was then monitored for a five-minute period. Following the five-minute experimental period the mesh floor of the plexiglass cage was removed and replaced with another clean screen floor. Nest boxes were replaced with other combinations and the procedure repeated.

The following nest box pairings were presented to ten different *Psithyrus* females: cotton only–cotton only, cotton only–*B. terricola* nest, cotton only–*B. affinis* nest, *B. affinis* nest–*B. terricola* nest, host nest–*B. bimaculatus* nest. The order in which these pairings were presented was determined randomly, except for the host nest–*B. bimaculatus* nest pairing, which was always

Table 1. Percent time spent by *Psithyrus ashtoni* females in either half of plexiglass cage covering nest pairs (N = 10).

	Cotton only	Cotton only	*terricola* nest	Cotton only	*affinis* nest	Cotton only	*affinis* nest	*terricola* nest	Host nest	*bimaculatus* nest
% time spent in cage-half	47.20	52.80	78.28	21.72	78.93	21.07	49.78	50.22	73.57	26.43
χ^2	0.470		47.997		50.228		0.003		37.332	
P	NS[1]		<0.001		<0.001		NS[1]		<0.001	

[1] Not significant at 0.05 level.

presented last. Left–right box pairings were also randomized. Each female *Psithyrus* was tested five times, one test for each pairing. The host nest chosen for the host nest–*B. bimaculatus* nest pairing was that nest over which the female *Psithyrus* spent the least time during the *B. affinis–B. terricola* test.

RESULTS

The preference of *P. ashtoni* females for nest odours of host and non-host bumblebees is shown in Table 1. Female *Psithyrus* were able to distinguish host nest odour from the odour of the nest material alone, and could also discriminate between the odour of host nests and non-host nests. Collectively, *Psithyrus* females showed no preference in the cotton–cotton and *B. affinis–B. terricola* pairings. When over a host nest the movements of female *Psithyrus* slowed, and they often spent considerable time chewing at the screen mesh floor, apparently attempting to get to the nest below. They never were observed chewing at the wire mesh floor when over nests containing only cotton, or when over *B. bimaculatus* nests.

It was not possible to determine individual preference for either *B. affinis* or *B. terricola* nests in one five-minute experiment period. Collectively the ten females used in this experiment showed no preference. Two *Psithyrus* females which spent greater than 70 percent of their time over *B. terricola* nests during the *B. terricola–B. affinis* pairings were given two additional five-minute periods under the same conditions. In one case the percent time spent over the *B. terricola* nest dropped to 48 percent; in the other, the preference for *B. terricola* nest odour remained high (78%).

DISCUSSION

The results support the hypothesis that *P. ashtoni* females can recognize host nest odour without actual contact with the nest or with worker-laid trails. The active detection distance of host nest odour is unknown. Plath (1934) found that when he dug up nests of *B. bimaculatus* he observed *P.*

citrinus females flying nearby making a 'bee-line' for the nests and alighting on them. Presumably, female *Psithyrus* can recognize nest odour while flying. *P. ashtoni* females characteristically fly a slow searching pattern close to the ground, often alighting and searching in detail under leaves and twigs. Since both *B. affinis* and *B. terricola* nest underground (Fisher, unpubl.), often with extensive tunnels leading to the nest, the female *Psithyrus* may at first be guided by sight to appropriate looking nest entrances, and then localize nests using odours.

That *P. ashtoni* can distinguish host nests from those of *B. bimaculatus* is consistent with their never being found in nests other than those of hosts. *P. ashtoni* females do not fight with host queens, but when placed in non-host nests are attacked by queens (Fisher, unpubl.). Mistakes in host identification in the field could be costly. It would be of interest to test generalist *Psithyrus* species in the same apparatus, using a variety of bumblebee nests as odour sources. I hypothesize that host odour discrimination is weakly developed in *Psithyrus* generalists.

The data presented here suggest that *P. ashtoni* females either do not discriminate between their two hosts, or that discrimination is weakly developed. More detailed analysis of individual responses is needed to satisfactorily answer this question. In areas where both hosts occur, *B. affinis* queens often usurp incipient nests of *B. terricola* (Plath, 1934; Fisher, unpubl.). A female *Psithyrus* invading a nest of *B. terricola* very early could find itself in a nest subsequently usurped by a *B. affinis* queen. It is unlikely that *B. terricola* host specificity could occur under these conditions. *P. ashtoni* from areas where *B. affinis* does not occur can be placed in laboratory nests of this species where they successfully rear offspring (Fisher, unpubl.). *B. terricola* and *B. affinis* are closely related phylogenetically and may have colony odours which are difficult to distinguish. *B. affinis* queens which usurp *B. terricola* nests are able, at least in small nests, to dominate *B. terricola* workers (Fisher, in prep.), indicating that there is some similarity in pheromonal communication between these species. The degree of relative nest parasitism which occurs in field colonies may simply depend on which host nests are first encountered by searching parasites.

ACKNOWLEDGMENTS

I thank Robin Stuart for reviewing the manuscript, and Trent University for generously supplying laboratory space. This research was supported by a NSERC post-graduate scholarship to Richard M. Fisher.

LITERATURE CITED

Alford, D. V. 1975. Bumblebees. Davis-Poynter, London.

Cederberg, B. 1977. Evidence for trail marking in *Bombus terrestris* workers (Hymenoptera, Apidae). Zoon 5:143–146.

Cederberg, B. 1979. Odour guided host selection in *Psithyrus* (Hym., Apidae). Ent. Tidscr. 100:128–129.

Fisher, R. M. Invasion success of the social parasite *Psithyrus ashtoni* in nests of its two bumblebee hosts. (Submitted.)

Plath, O. E. 1922. Notes on *Psithyrus*, with records of two new American hosts. Biol. Bull. Wood's Hole 43:23–44.

Plath, O. E. 1934. Bumblebees and Their Ways. New York.

Plowright, R. C. and S. C. Jay. 1966. Rearing bumblebee colonies in captivity. J. Apic. Res. 5:155–165.

Pomeroy, N. and R. C. Plowr:ght. 1980. Maintenance of bumble bee colonies in observation hives (Hymenoptera:Apidae). Can. Ent. 112:321–326.

Sladen, F. W. L. 1912. The Humblebee, Its Life History and How to Domesticate It. London.

Received January 21, 1983; accepted April 19, 1983.